

REMARKS

Claims 1-18 remain pending in this application. Claim 17-18 have been withdrawn from consideration as being directed to a non-elected species. Each of the examined claims is believed to define an invention which is novel and uobvious over the cited references. Favorable reconsideration of this case is respectfully requested.

The present invention relates to a method of etching semiconductor devices using a hydrogen peroxide-water mixture. The hydrogen peroxide-water mixture is used to etch a titanium or titanium nitride film which is arranged over an cobalt silicide film. Etching the titanium or titanium nitride film arranged over the cobalt silicide film prevents thinning of the cobalt silicide film that occurs in the prior art, please see the present specification, for example page 5, lines 15-20.

Claims 1, 4, 5, 9, 12, 13 and 16 have been rejected under 35 U.S.C. 103(a) as being unpatentable over Applicants admitted prior art in view of U.S. Patent Number 6,245,191 to Derderian et al.

Claims 1, 4, 5, 9, 12, 13 and 16 have been rejected under 35 U.S.C. 103(a) as being unpatentable over Applicants admitted prior art in view of Derderian.

As noted in the Office Action, Applicant's admitted prior art fails to teach etching using a hydrogen peroxide-water mixture. Derderian is cited as teaching this feature.

Derderian discloses a hydrogen peroxide solution in water as an example of a solution that is capable of etching titanium nitride. Derderian also discloses that hydrogen peroxide and ammonium hydroxide in water may also be employed to etch

titanium nitride. Various other solutions, such as sulfuric acid-hydrogen peroxide-water and hydrochloric acid-hydrogen peroxide-water disclosed in Table 1 on page 15 of the present specification, may also be used to etch titanium nitride. Accordingly, the cited art teaches at least four different solution capable of etching titanium nitride.

In comparison, the amended claims recite that a titanium nitride film which is arranged over cobalt silicide is removed using a hydrogen peroxide-water mixture. None of the cited references teaches to select a hydrogen peroxide-water mixture for etching titanium nitride arranged over cobalt silicide. Derderian merely discloses an example of a solution capable of etching titanium nitride. There is no disclosure in Derderian whatsoever to teach or suggest selecting hydrogen peroxide-water solution from the various solutions disclosed in the prior art at to use the hydrogen peroxide-water solution to etch a titanium nitride layer arranged over a cobalt silicide layer.

Moreover, claims 9-16 recite that the titanium nitride is etched using a hydrogen peroxide solution containing ammonia and a second portion of the titanium nitride film is removed using a hydrogen peroxide-water mixture so that the surface of the cobalt silicide film is exposed without etching thereof. Only by selecting the hydrogen peroxide-water solution from the various solutions disclosed in the cited references can the titanium nitride be etched without etching of the cobalt silicide. There is no teaching or suggestion in Derderian of employing a hydrogen peroxide-water solution on cobalt silicide or that the titanium nitride on a cobalt silicide layer can be removed in a short time without causing defective etching in a cobalt silicide layer.

“The Examiner must show reasons that the skilled artisan, confronted with the same problems as the inventor and with no knowledge of the claimed invention, would select the elements from the cited prior art references for combination in the matter claimed.” *In re Rouffet* 47 USPQ2d 1453, 1458 (Fed. Cir. 1998).

In view of the above discussion, it is clear that the cited references do not teach or suggest the use of a hydrogen peroxide-water solution to etch the titanium nitride film arranged over and cobalt silicide film as is recited in the present claims. Therefore, the withdrawal of the above rejections is respectfully requested.

If the Examiner is of the opinion that the prosecution of this application would be advanced by a personal interview, the Examiner is invited to telephone undersigned counsel to arrange for such an interview.

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached page is captioned “Version with markings to show changes made.”

Amendment
U.S. Application No. 09/639,163

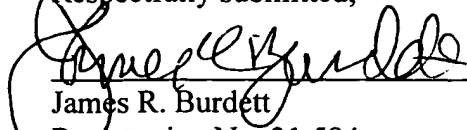
The Commissioner is authorized to charge any fee necessitated by this
Amendment to our Deposit Account No. 22-0261.

Date

1/7/2003

JRB/JAK/lrh
DC2/425881

Respectfully submitted,



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VERSION SHOWING CHANGES MADE

IN THE CLAIMS:

Please amend the claims as follows:

1. (Amended) A method of producing semiconductor devices by cobalt silicide technology with titanium nitride film as the cap film, comprising:

removing said titanium nitride film which is arranged over underlying cobalt silicide film using a hydrogen peroxide-water mixture.

4. (Amended) A method of producing semiconductor devices, comprising:

forming cobalt film on the top surface of a silicon substrate, which has a gate electrode and a diffusion layer;

forming titanium nitride film as the cap film on the top surface of said cobalt film;
selectively reacting the silicon of said silicon substrate and the cobalt of said cobalt film; and

removing said titanium nitride film which is arranged over underlying cobalt silicide film using a hydrogen peroxide-water mixture.

5. (Amended) A method of producing semiconductor devices by cobalt silicide technology with titanium film as the cap film, comprising:

removing said titanium film which is arranged over underlying cobalt silicide film using a hydrogen peroxide-water mixture.

8. (Amended) A method of producing semiconductor devices, comprising:

forming cobalt film on the top surface of a silicon substrate, which has a gate electrode and a diffusion layer;

forming titanium film as the cap film on the top surface of said cobalt film;

selectively reacting the silicon of said silicon substrate and cobalt of said cobalt film; and

removing said titanium film which is arranged over underlying cobalt silicide film using a hydrogen peroxide-water mixture.

9. (Thrice Amended) A method of producing semiconductor devices by cobalt silicide technology with titanium nitride film as the cap film, comprising:

removing a first portion of said titanium nitride film which is arranged over underlying CoSi-cobalt silicide film by a first removal step using an ammonia-hydrogen peroxide-water mixture such that a second portion of said titanium nitride film remains covering said CoSi-cobalt silicide film; and

removing said second portion of said titanium nitride film on said CoSi-cobalt silicide film by a second removal step using a hydrogen peroxide-water mixture so as to expose a surface of the cobalt silicide film without etching thereof.

12. (Thrice Amended) A method of producing semiconductor devices, comprising:

forming cobalt film on the top surface of a silicon substrate, which has a gate electrode and a diffusion film;

forming titanium nitride film as the cap film on the top surface of said cobalt film; selectively reacting the silicon of said silicon substrate and the cobalt of said cobalt film;

removing a first portion of said titanium nitride film which is arranged over underlying CoSi-cobalt silicide film by a first removal step using an ammonia-hydrogen-peroxide-water mixture such that a second portion of said titanium nitride film remains covering said CoSi-cobalt silicide film; and

removing said second portion of said titanium nitride film remaining on said CoSi-cobalt silicide film by a second removal step using a hydrogen peroxide-water mixture so as to expose a surface of said cobalt silicide film without etching thereof.

13. (Thrice Amended) A method of producing semiconductor devices by cobalt silicide technology with titanium film as the cap film, comprising:

removing a first portion of said titanium film which is arranged over underlying CoSi-cobalt silicide film by a first removal step using an ammonia-hydrogen peroxide-water mixture such that a second portion of said titanium nitride film remains covering said CoSi-cobalt silicide film; and

removing said second portion of said titanium film remaining on said ~~CeSi~~-cobalt silicide film by a second removal step using a hydrogen peroxide-water mixture so as to expose a surface of said cobalt silicide film without etching thereof.

16. (Thrice Amended) A method of producing semiconductor devices, comprising:

forming cobalt film on the top surface of a silicon substrate, which has a gate electrode and a diffusion layer;

forming titanium film as the cap film on the top surface of said cobalt film;

selectively reacting the silicon of said silicon substrate and the cobalt of said cobalt film;

removing a first portion of said titanium film which is arranged over underlying ~~CeSi~~-cobalt silicide film by a first removal step using an ammonia-hydrogen peroxide-water-mixture such that a second portion of said titanium film remains covering said ~~CeSi~~-cobalt silicide film, and

removing said second portion of said titanium film remaining on said ~~CeSi~~-cobalt silicide film by a second removal step using a hydrogen peroxide-water mixture so as to expose a surface of said cobalt silicide film without etching thereof.

17. (Amended) An etching liquid, which is a hydrogen peroxide-water mixture for removal of titanium nitride film on the top surface of cobalt film or cobalt silicide (CoSi).

18. (Amended) An etching liquid, which is a hydrogen peroxide-water mixture for removal of titanium film on the top surface of cobalt film or cobalt silicide (CoSi).